ENVIRONMENTAL REPRESENTATION AND THE ROLE OF CLOUDS IN STUDIES AND ANALYSIS MODELS

By:
John R. Hummel and A. Peter Campbell
Argonne National Laboratory

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HOW CLOUDS CAN IMPACT STUDIES AND ANALYSIS APPLICATIONS

- Impact of Ceiling on Air Operations
- Sources of Precipitation, Impacting:
  - Mobility of Moving Systems (Vehicles and Human)
  - Thermal Conditions of Surfaces
  - Surface and Atmospheric Optical/Radiative Properties
  - Water Acoustic Properties
  - Human Performance (Morale, Physical State, …)
- Impact on Performance of Sensing Systems (e.g. Visible, Infrared, Lasers, …)

HOW CLOUDS CAN IMPACT STUDIES AND ANALYSIS APPLICATIONS (Cont.)

- Role in the Energy Budget:
  - Reduction in Solar Loading
  - Source of Infrared Flux
- Impact on Platform Performance:
  - Icing
  - Contrail Formation
  - Reentry Vehicles
- Impact on Command and Control/Decision Making
  - ATO Generation
  - Go/NoGo Decisions on Targeting
  - Response Time After Detection (e.g. TMD, BMD)

SIMILARITIES AND DIFFERENCES BETWEEN TRAINING AND ANALYSIS APPLICATIONS

Similarities

- Training and Analysis Applications Can Both Require Environmental Representation of Clouds and Their Impacts Over a Large Spatial Extent (*I.e.* a Theater) With a Requirement for a Fine Scale Representation on a Local Basis (*I.e.* Squad or Individual Platform)

- The Types of Cloud Phenomenon Required are Often the Same With the Differences Appearing in the Levels of Detail Being Implemented

SIMILARITIES AND DIFFERENCES BETWEEN TRAINING AND ANALYSIS APPLICATIONS (Cont.)

Differences

- Analysis Applications Often Require Simulations Covering Long Time Periods (~30 - 120 days) While Training Applications are Generally Much Shorter

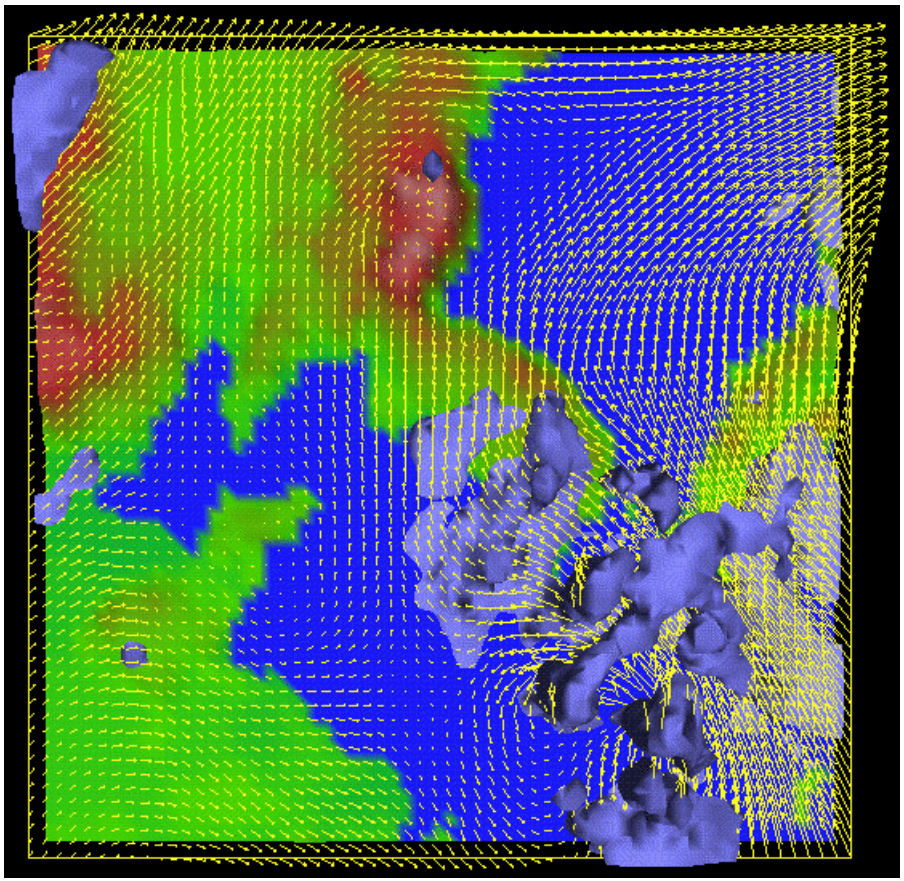
- Training Applications May Require Real-Time Service of Environmental Data While Analysis Applications Work at Faster Than Real-Time Rates With Environmental Representation Being Provided Over Longer Time Scales (~ Hours)

SIMILARITIES AND DIFFERENCES BETWEEN TRAINING AND ANALYSIS APPLICATIONS (Cont.)

Differences

- Training Applications Put a Large Emphasis on Visual Scene Representation While the Analysis Community Generally Wants a 2-D “Big Picture” View During Simulation Set-up That is Often Turned Off During Simulation Execution
- The Training Community is Often Considered With Perceived Reality Rather Than Physics Based “Truth”
- Analysis Applications Must be Able to Understand “Why” an Event Occurred as Well as When

PROVIDING CLOUD AND ATMOSPHERIC PHENOMENA IN ANALYSIS APPLICATIONS



- **MM90**: Parallelized, High Resolution, Non-Hydrostatic Model With Nested Irregular Grids, Multiple Levels of Nesting, and Feedbacks Between Grids
- ANL Delivered MM90 to the USAF for Use in the GWC Theater Level Forecast Model Testbed

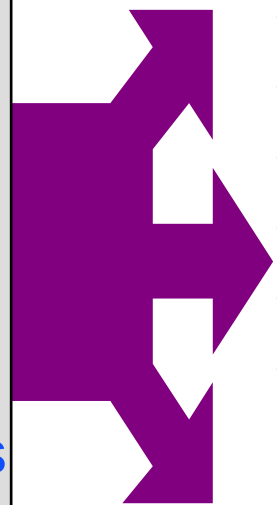
JWARS MISSION, USERS, AND USES

- In 1995, the Joint Analytic Model Improvement Program (JAMIP) was Initiated to Upgrade Existing Joint Analytic Models and to Develop a Set of Next Generation Models for Use by the Analysis Community

- **The JWARS Mission:** "Develop a State-of-the-Art, Closed Form Simulation of Joint, Campaign-Level Warfare That:
  - Represents Uniquely Joint Functions and Process and Component Warfare Operations
  - Is Based On Joint Doctrine
  - Is Capable of Representing Future Warfare
  - Supports Analysis"

JWARS MISSION, USERS, AND USES (Cont.)

Users:
- CINCs
- Joint Staff
- JWCA
- Services
- OSD
- Other DoD Orgs

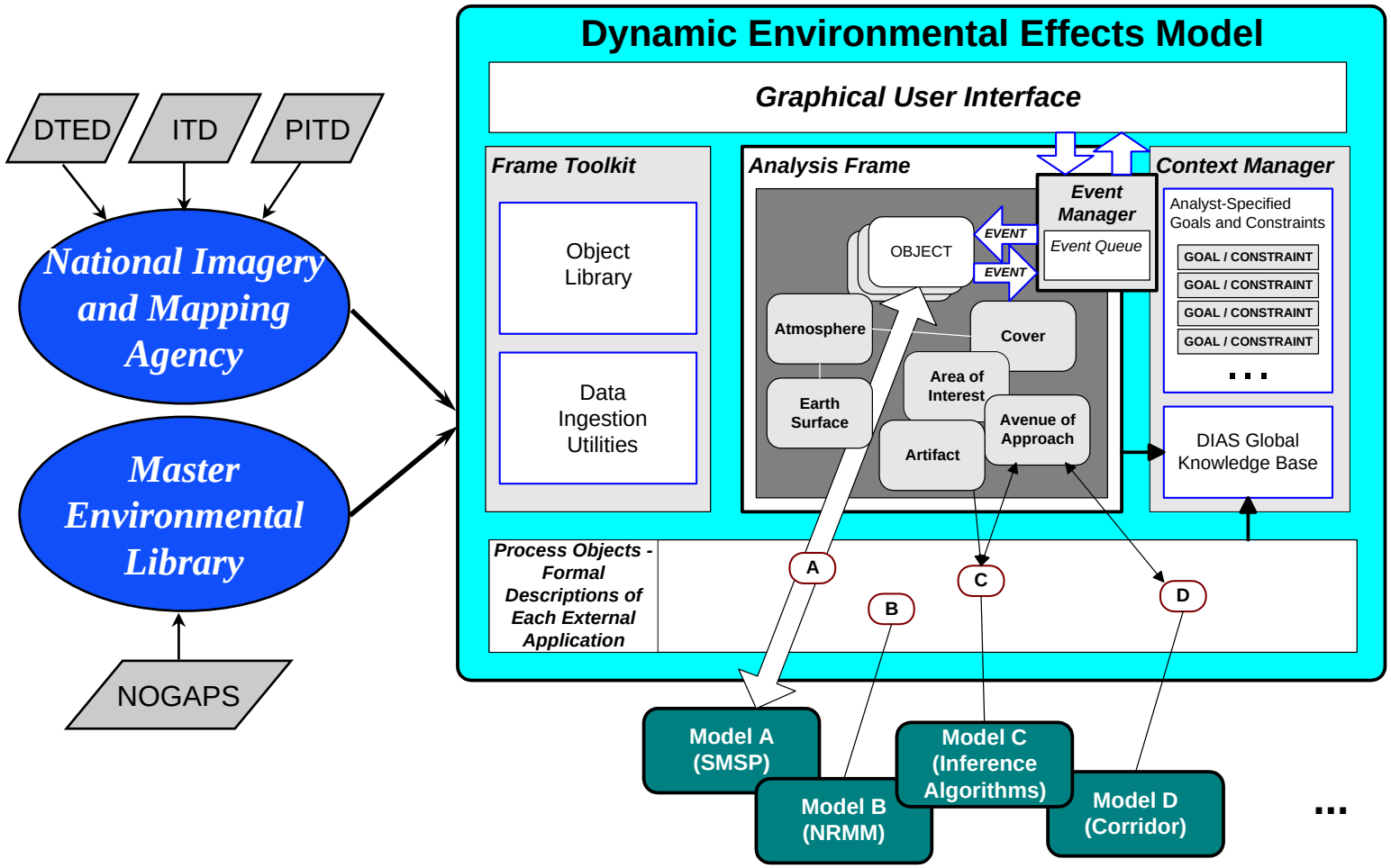


Uses:
- Evaluation of Courses of Action (COAs)
- Analysis of Force Sufficiency
- Issue Development
- Joint Capability Trade-off
- Analysis of System Alternatives
- System Trade-off
- Objective Force Planning and Force Structure Design
- Examination of Operational Concepts
- Force and System Trade-offs

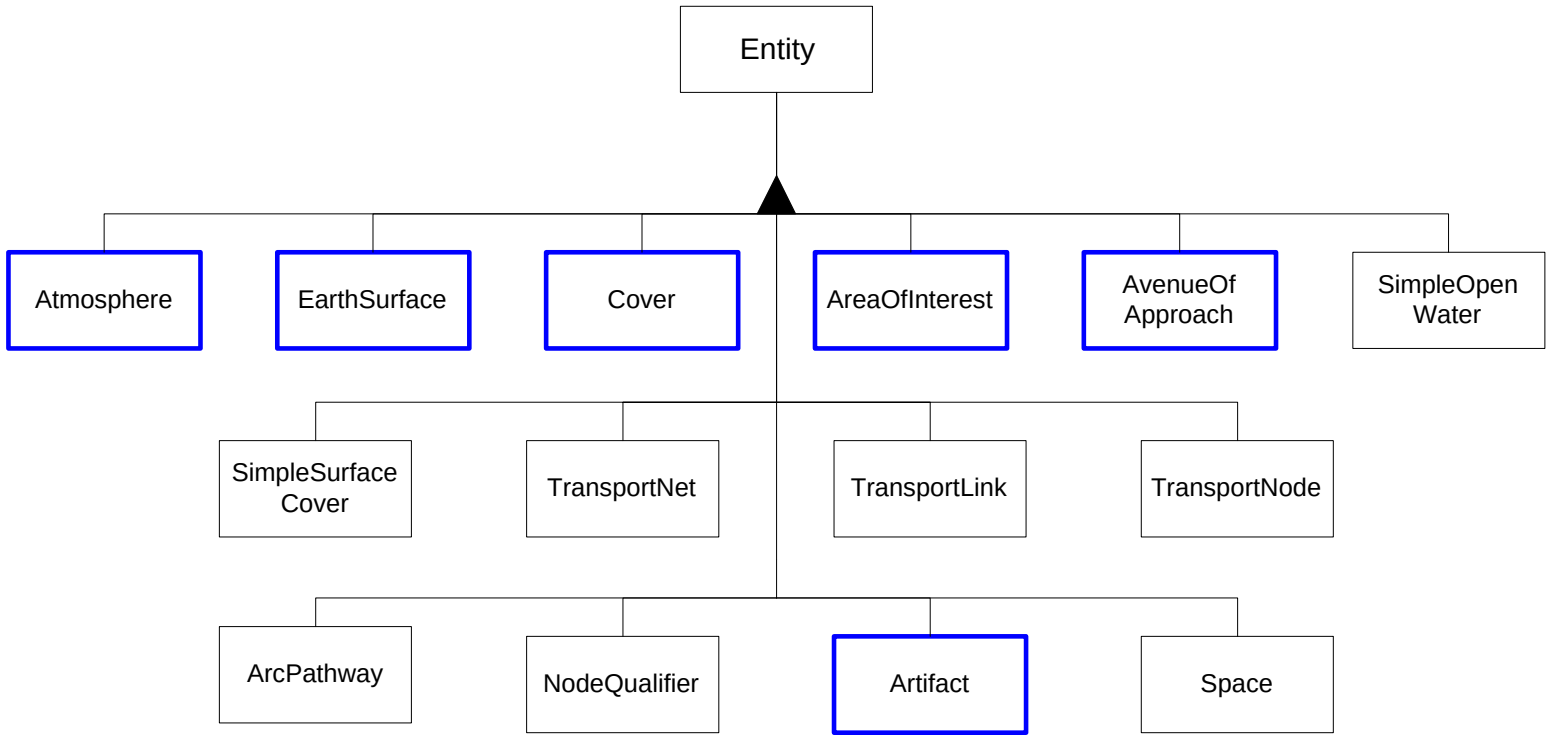
ENVIRONMENTAL REPRESENTATION IN THE JWARS PROTOTYPE

- Argonne Provided the Simple Environmental Representations Needed for the JWARS Prototype:
  - Earth Surface, Atmosphere, Simple Open Water, and Transportation Related Objects Were Developed
  - Environmental Effects Functionality Based on Standard DoD Models Provided by DoD Organizations (e.g. WES)
  - Environmental Data Provided by NIMA and MEL Based on Authoritative Sources

ENVIRONMENTAL REPRESENTATION IN THE JWARS PROTOTYPE (Cont.)

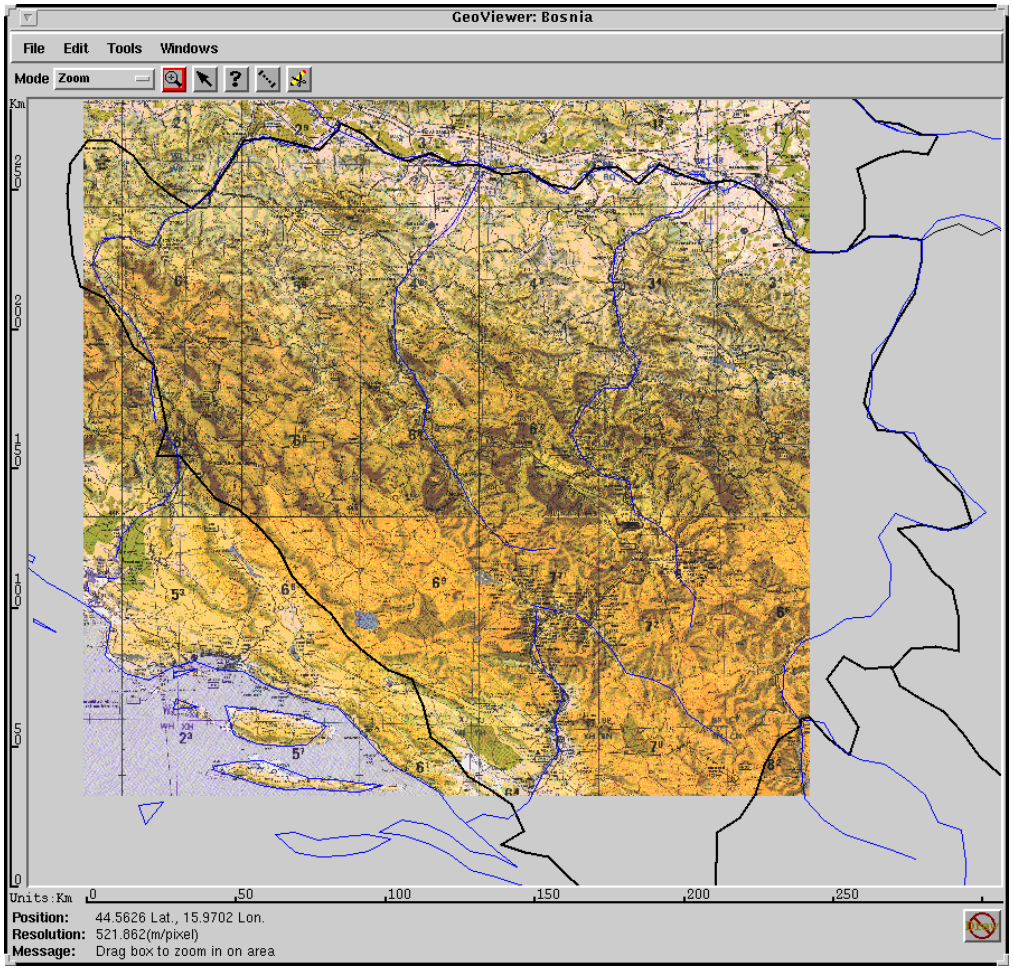


ENVIRONMENTAL OBJECTS IN JWARS PROTOTYPE



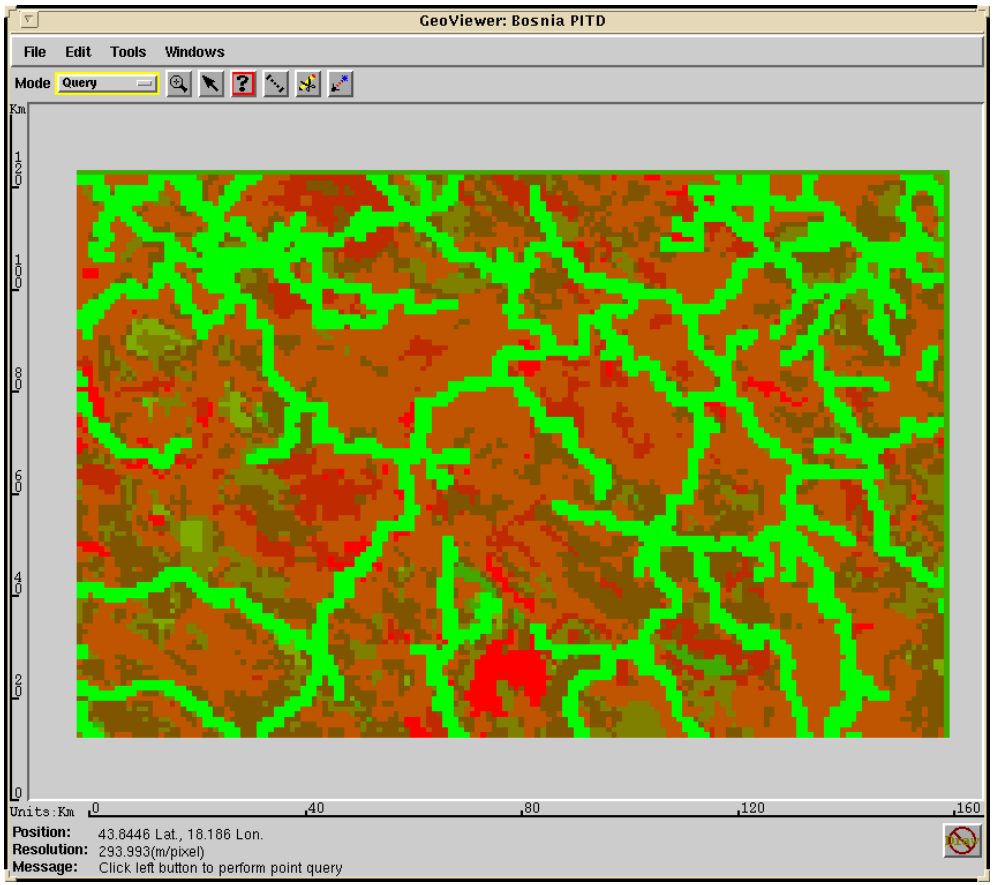
- All Objects, Except Space, Have Been Implemented in Code
- Objects In Heavy Solid Lines Provided Environmental Effects Functionality to the JWARS Prototype

ENVIRONMENTAL REPRESENTATION IN THE JWARS PROTOTYPE



- Study Area is Bosnia
- Atmospheric Data Provided by MEL - NOGAPS Data for 6/22/96 to 7/22/96
- Cloud Amounts Were Inferred From ΔT_{dp}
- Land Data From NIMA
  - –VITD, DTED
  - –ADRG Maps

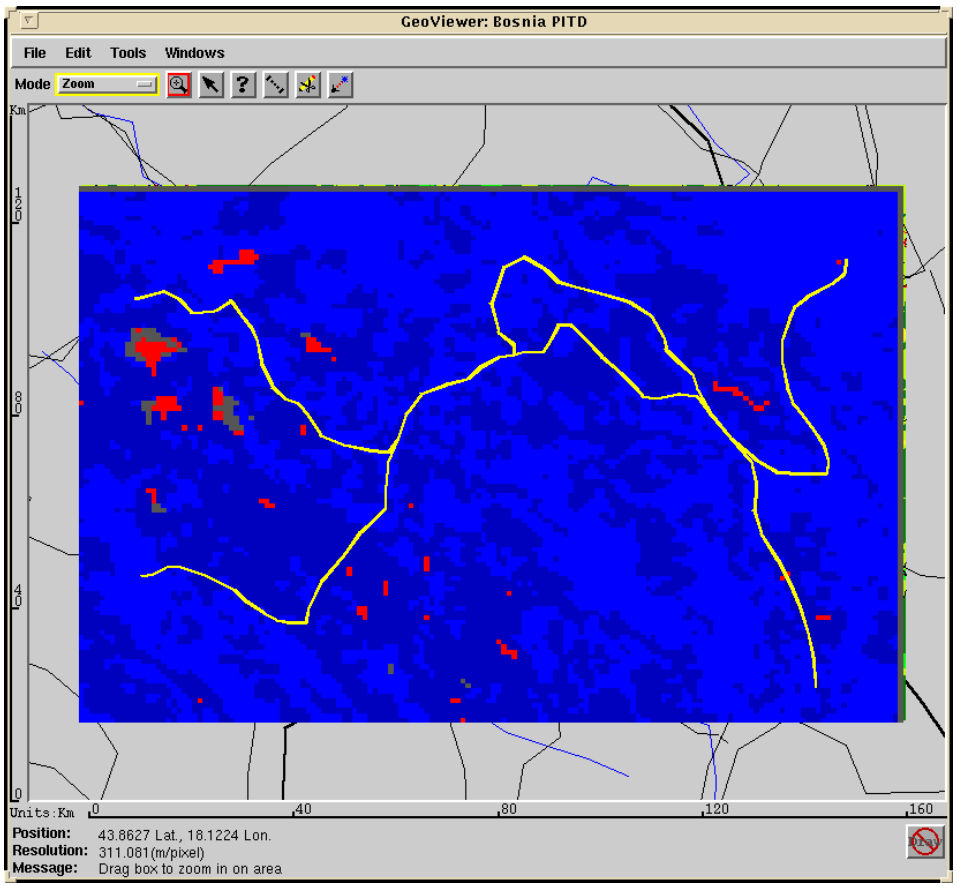
ENVIRONMENTAL REPRESENTATION IN THE JWARS PROTOTYPE (Cont.)



Functionality Provided Includes Environmentally Dependent:

- Vehicle Mobility
- Divisional Mobility Corridors
- Avenues of Approach and Named Areas of Interest
- Line-of-Sight With Cloud Obscuration and Terrain Masking

ENVIRONMENTAL REPRESENTATION IN THE JWARS PROTOTYPE (Cont.)



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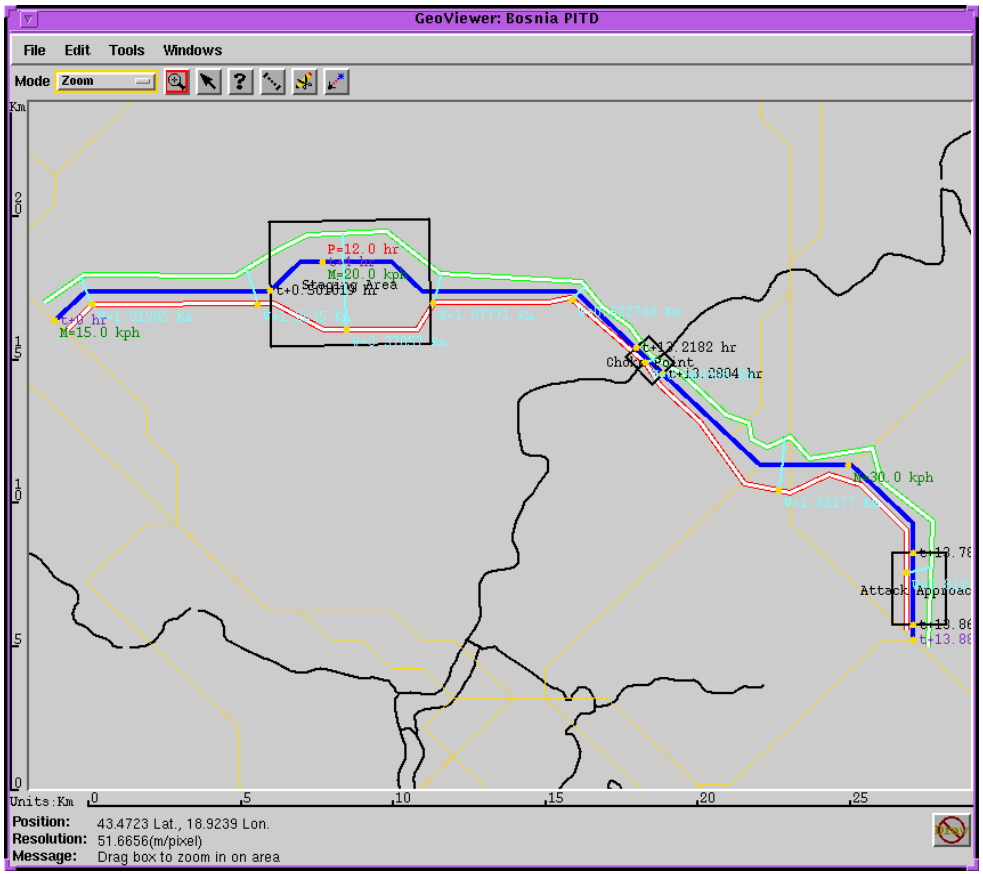

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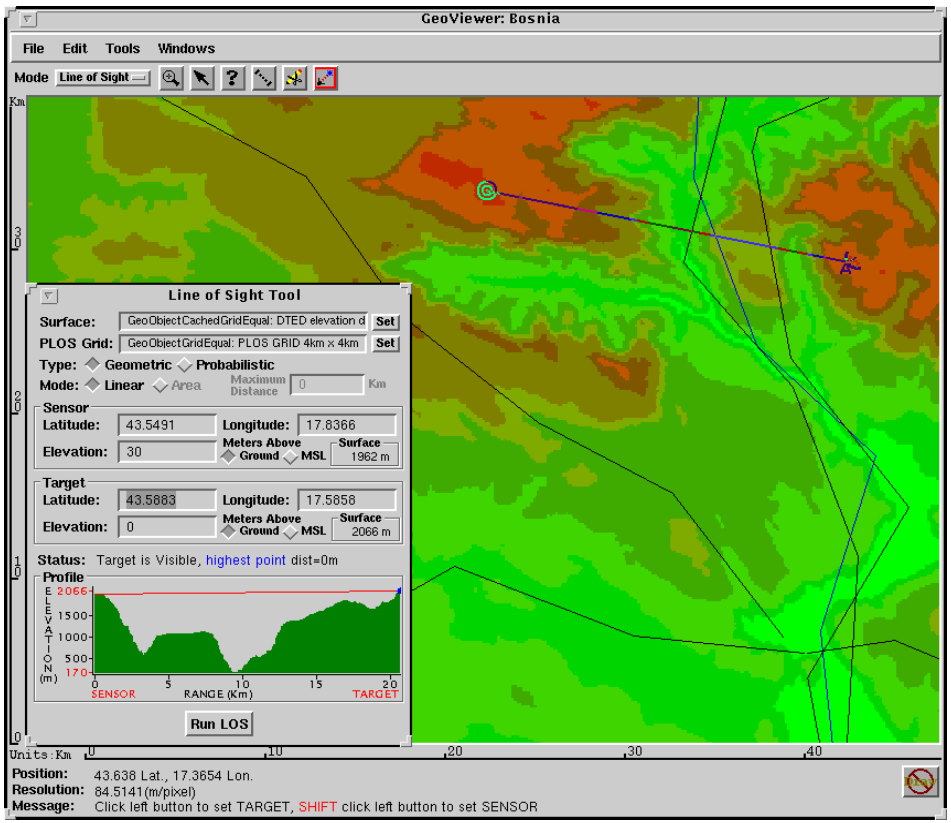

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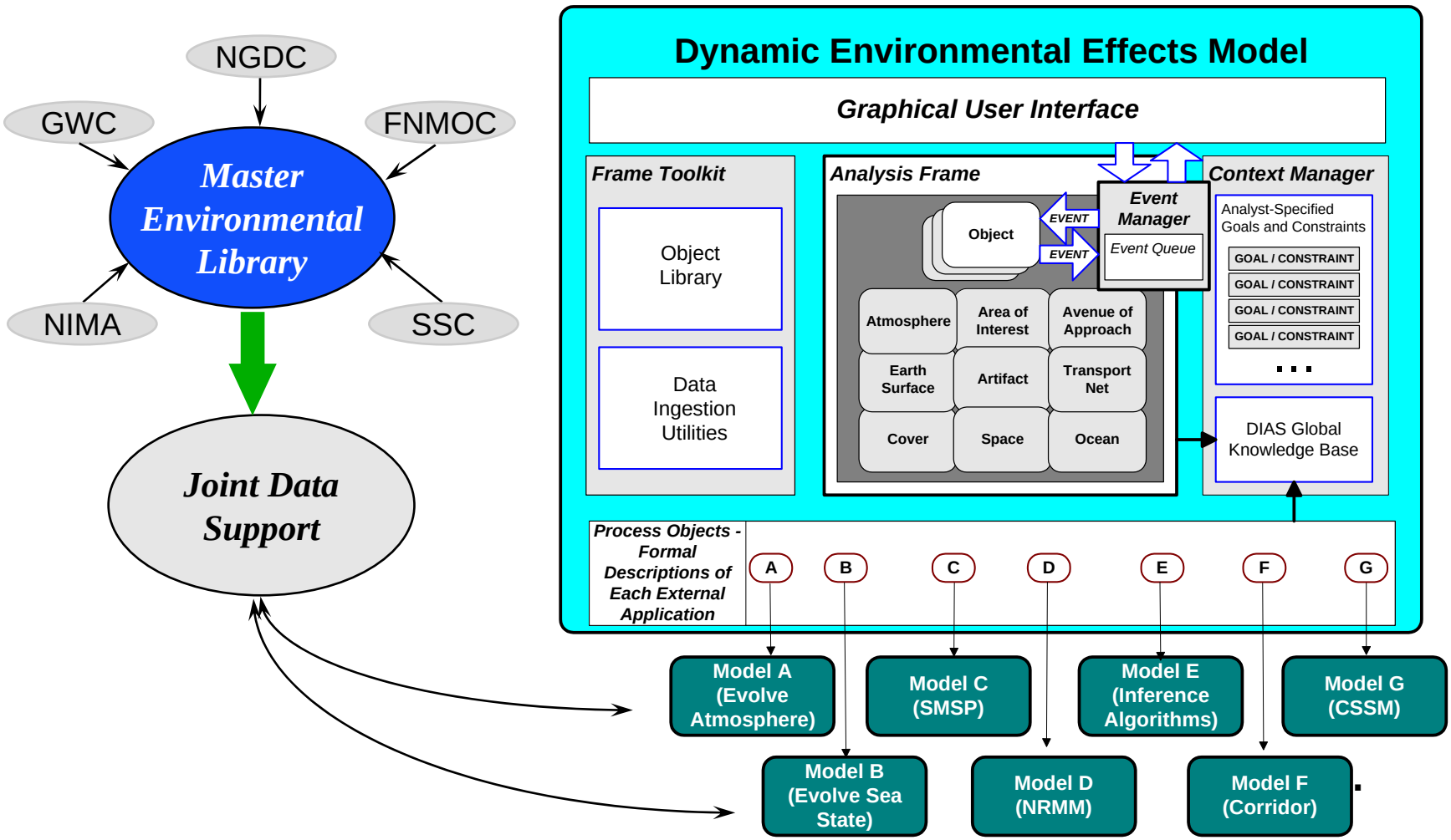
ENVIRONMENTAL REPRESENTATION IN THE JWARS PROTOTYPE (Cont.)

- During the JWARS Prototyping Effort, Clouds Were a Significant Factor in the Modeled Use Cases - Sensing Platforms Missed Targets on the Ground Due to the Cloud Cover

ENVIRONMENTAL REPRESENTATION IN THE JWARS PRODUCTION SYSTEM



ENVIRONMENTAL REPRESENTATION IN THE JWARS PRODUCTION SYSTEM

- Expand and Revise the Object Taxonomy and Functionality to Leverage DEEM/DIAS Evolution:
  - Hydrologic Objects
  - Infrastructure (e.g. Transportation) Objects
  - Command and Control Objects
- Enhance the Existing *Atmosphere* Object and Functionality, Including Enhanced Cloud Representation For Sensor Evaluation Applications
- Integrate Surf Zone/Littoral Models
- Develop a Space Object and Functionality